DEVELOPMENT OF FORCE SENSE DETECTION AND PRESENTATION MECHANISM FOR THE PURPOSE OF CONSTRUCTING FORCE SENSE PRESENTATION SYSTEM IN LEADER/FOLLOWER INTEGRATED ROBOT FORCEPS

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ABSTRACT

Most of the surgical support robots currently in widespread use are remotely operated, with the leader part operated by the surgeon and the follower part working inside the patient's abdominal cavity. Because of this feature, the force (force sense) that the forceps tip grasps the organ is not transmitted to the surgeon, increasing the risk of accidentally damaging the organ when the forceps tip grasps the object. Therefore, this study aims to develop a robotic forceps with an integrated leader and follower to reduce the workload of the surgeon. Compared to forceps manipulation similar to conventional laparoscopic surgery, the Leader/Follower integrated robotic forceps enables more intuitive manipulation by expanding the working range and adding a force sensation presentation function.

The force perception presentation system to be constructed in this study consists of two axes, "force detection" and "force perception presentation. In the force sensation detection, the force at which the forceps tip grasps an organ is estimated from the load current value of the motor. In the force perception presentation, the grasping force estimated by the force perception detection is transmitted to the surgeon's hand.

Comparing the force detection accuracy of the gear-driven test machine fabricated by force detection and that of the wire-driven test machine fabricated in a previous study, the gear-driven test machine showed improved force detection accuracy. It was confirmed that the first target was satisfied in the force detection within the required grasping force range of the surgical support robot. To satisfy the second goal, we propose to improve the experimental environment.

For the force perception presentation, a pneumatic ring was fabricated as a device to be attached to the surgeon's fingertip. This device is in the form of a ring made of rubber and can be attached to the fingertip without interfering with the surgeon's operation. Experiments using a test machine to verify the usefulness of the pneumatic ring showed that the presentation principle of the pneumatic ring is useful. However, the durability to present the required grasping force was insufficient.

In the future, we will improve the test machine for the pneumatic ring and manufacture a structure that can satisfactorily present the required gripping force. In addition, we will conduct experiments with the pneumatic ring installed, and conduct qualitative evaluation and quantitative evaluation.